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Challenges for Teachers' and Students' Digital Abilities: A Mixed Methods Design Study

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Abstract: Digital education is a recently highlighted challenge for educational innovation. This study aimed to discover the educational conditions in which teachers and students may be involved during the pandemic, and how these may affect teachers' workload and educational quality. A Mixed Methods Design was used, where quantitative and qualitative data were obtained and analyzed. An ad hoc questionnaire was created and sent to teachers of different levels of education (pre-university) and types of school (public and private). Predictive variables of working hours were analyzed by carrying out a multiple regression. Moreover, changes experienced by teachers were studied by analyzing qualitative data. The variables type of teaching, students' access to electronic resources, and instant training in online teaching predicted teachers' working hours. Furthermore, participants cited having changes in workload and being overwhelmed during this period, having less contact with students, and experiencing changes in working environment as the most important variables affecting the new working conditions. In conclusion, teachers' training in online education and the provision of electronic resources for students should be a priority to make online learning possible, to avoid the problem of teachers needing to perform extra work in similar future conditions, and to foster educational innovation.

Keywords: digital education; teachers; students; resources; mixed methods design

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1. Introduction

Educational innovation is understood as the permanent training of teachers to adapt and respond to the current needs of their students and society. This is due to, among other things, existing advances in digital telecommunications, as well as all technological advances. All of this implies a change in the educational field and consequently the continuous training of teachers, in order to give an effective, as well as an efficient response to society and to foster students' digital abilities [1]. Society changes constantly and this condition directly affects education. Therefore, education professionals must be continuously trained to develop the needed skills that allow quality in teaching and learning [2].

Educational innovation can be crucial to improve quality in teaching and learning. However, its implications in modifying the largely used methodologies in school classrooms influences the conceptions, the beliefs, and the well-being of teachers [3]. In education, in recent decades, there has been a shift towards non-traditional methodological strategies, as well as the increasing use of technological resources, the so-called Information and Communication Technologies (ICT). In this respect, the European Commission [4] is concerned with promoting innovative pedagogies in science education to attract young people, with a

special emphasis on girls (due to a smaller involvement in STEM careers), and to address the challenges that have careers in science, technology, engineering, and innovation to foster scientific citizenship. Thus, the program Horizon 2020, in its specific section Science Education, considers building capacities and connecting science to society in innovative ways a priority, as it is crucial to a sustainable and cross-cutting interaction between several relevant actors, among them teachers and students. Therefore, in Europe, in the educational systems, digital education and the use of technology resources (i.e., Moodle, virtual educational platforms) as well as new innovative methodologies (i.e., Problem-Based Learning) have spread [5]. Also, the needs of education and the requirements made to students have changed, so that students are asked to solve real problems and to use virtual tools through online platforms [6]. Furthermore, in the current digital age, the traditional learning approach with the focus on the instructor as the center of knowledge is irrelevant, considering the use of the Internet and all its learning possibilities [7]. New technologies give students the option to increase autonomy in learning, by replacing the classic blackboard with online lessons and resources, such as videos or educational readings [8]. In this line, it is worth mentioning that although it is true that there are already many classrooms with virtual screens and centers whose students use tablets, it is not clear if those are merely replacing blackboard and paper for screens. Other methodological purposes or digital competences should be considered instead of applying the same traditional classroom and teacher-student roles. It is unknown what the percentage of teachers and students who may be teaching and learning electronically is and what strategies they are using electronics for. What is clear is that the figure of the teacher and their role must be redefined as creative and innovative [9]. Monroy et al. [10], in their study, found that even when technology could be used to improve educational achievement, virtual classrooms were not used by students, since these have not been fully implemented by teachers. All of this indicates that although in teaching-learning processes educational platforms have been introduced, the impact that these have on the learning level and abilities of students is unknown. It is important to know how the students perceive and understand the classes using these technologies. Likewise, training teachers for the proper use of ICT is essential, since they are not prepared enough to make adequate use of them [11,12].

In 2020, an unexpected worldwide situation has given us the unique opportunity to study teachers' and students' digital competences and their digital resource availability. The lockdown situation globally established due to the disease COVID-19 has caused face-to-face academic activities to be replaced by online education [13], so that education professionals have had to leave the traditional classes and become experts, sometimes without prior training, in new technologies, and thus interact remotely with their coworkers and with students [14]. The need to plan and to meet other professionals became time consuming, and this fact had an opposite effect on the time dedicated to students [11], directly affecting the quality of education and their own lives. Meanwhile, teachers have had to deal with the personal problems of the lockdown and its economic, health, and/or affective implications [15]. According to García-Peñalvo [16], shortcomings and limitations of the educational system have emerged. However, difficulties with learning during the lockdown situation have been related to the lack of learning resources, such as the internet, in previous studies [17]. It is expected that other variables may play a special role. According to our knowledge, a few studies have considered teachers' working conditions in the lockdown situation to make known the challenges related to teachers' and students' digital abilities. Moreover, none of the studies have considered a mixed method design to explore the variables that could be related to those conditions. Therefore, this study aims to know how different variables, related to the use of digital and new educational methods, may affect the teaching conditions in terms of time (teaching or working hours) and changes in professional performance.

2. Materials and Methods

2.1. Participants

In this research, 345 teachers aged between 23 and 65 years old (M age = 44.62, SD = 9.54), including 264 women, 80 men, and 1 who did not specify sex, most teaching in primary and secondary education (see Table 1), took part. Participants were currently working in Spanish public schools (n = 258), private schools (n = 52), and in State funded private schools (n = 35). Among participants, only 5 had positive COVID-19 cases at home while 10 did not know at the time, and 28.1% of the sample (97) manifested having dependent people and 44.6% having minor children (154). Housing units' characteristics are shown in Table 1.

Table 1. Teachers' professional and convivial characteristics.

	Characteristics	Frequency	Percentage
Teaching educational levels	Primary education (6–12 years old)	71	20.6
	Secondary education (12–16 years old)	77	22.3
	Post-compulsory secondary education (16–18 years old)	17	4.9
	Others (i.e., languages, sports, arts)	53	15.4
	More than one level	127	36.8
Housing units' characteristics	Living in couple	76	22.0
	Living in their own family	26	7.5
	Living in their family of origin	200	58.0
	Living alone	41	11.9
	Living in other conditions	2	0.6

2.2. Design

In this study, a Mixed Methods Design has been used. This is known as the third paradigm [18,19], and it is mainly characterized by inclusion of both quantitative and qualitative methods in the same research, specification in the design of the sequence and weight of each part, and explanation of the link between them [20]. The design applied in the current study, so called concurrent triangulation, gives the same weight to qualitative and quantitative data [21].

2.3. Instruments

An ad hoc questionnaire consisting of 4 groups of questions was created for data collection. These included questions related to sociodemographic variables, family and housing issues, teaching working conditions, and some open questions (see Table 2).

Table 2. Asked questions in the ad hoc questionnaire.

1. Descriptive characteristics of participants
Sex Age
2. Family and housing characteristics
Who does live with you? Have you got dependent people in your charge? Have you got minor children? How many coronavirus cases are there in your immediate family?
3. Academic context's characteristics
In what kind of school do you work? In which level of education do you teach? How many hours of teaching per week did you had during lockdown? What kind of teaching method did you used during lockdown? Have you had the need to take online training to face teaching during lockdown? Do your students have electronic resources?
4. Open questions
What changes have you seen in your professional performance? How do you feel about it?

2.4. Procedure

Once the Ethics Committee's (CEIBA) approval [CEIBA2020-0401] was obtained, a Google Form questionnaire with the mentioned questions was sent to participants. The method used to recruit participants was a non-probabilistic snowball sampling procedure. For that purpose, in the month of May 2020, that is, during the lockdown period due to the disease COVID-19 pandemic, the questionnaire was sent to participants by using social networks (WhatsApp, Facebook, and Twitter), and corporate emails. All participants provided the informed consent to participate in the study. Therefore, the study is in accord with the Declaration of Helsinki and the Organic Law 3/2018, of the 5th of December, about Personal Data Protection and digital rights warranty.

2.5. Data Analyses

On the one hand, a multiple regression was carried out with the program IBM SPSS v.24 to determine which variables were related to the teaching time spent by teachers. On the other hand, a phenomenological discourse analysis method for qualitative data, which identifies the meanings of language through lexical analysis, was applied by using the ALCESTE (Lexical Analysis of Co-occurrences in Simple Text Statements) software [22]. This software uses statistical procedures to extract essential information from a text, in such a way that it will receive essential information from itself, quantifying its strongest lexical structures, and grouping the co-occurrence. The co-occurrence is the association by proximity of various words (nouns, adjectives, or verbs) using the Chi-square statistic, with the aim of differentiating the most significant lexical word. Thus, the software converts qualitative data into quantitative data by following the Reinert method [22]. The unit of analysis is the Elementary Context Unit (ECU), which corresponds to the idea of a sentence or a set of between 8 and 20 words [23]. One of the advantages of this approach is that it avoids the subjectivity involved in the construction of categories by the researcher, since the computer program establishes the connections using statistical procedures [24].

3. Results

3.1. Quantitative Data Analyses

Participants were asked about the type of teaching they were employing during the lockdown: Regarding traditional teaching (sending and correcting homework, tutoring with students via email), 22 teachers (6.4%) admitted using only this type; as for online teaching (streaming or recorded classes, streaming tutoring), 72 participants (20.9%) used this type; finally, 251 teachers (72.7%) admitted using a mixed teaching type (both teaching procedures). Moreover, teachers were asked to determine how many of their students (none, a minority, half, most, all of them, or does not apply) had the needed availability of electronic resources (i.e., internet, computer, or printer) during the lockdown. Table 3 shows the availability of electronic resources estimated by the teachers.

Table 3. Availability of students' electronic resources.

Availability of Resources	Frequency	Percentage
None (0%)	1	0.3
A minority (25%)	23	6.7
Half of students (50%)	87	25.2
Most of students (75%)	173	50.1
All students (100%)	57	16.5
Does not apply	4	1.2

Furthermore, a multiple regression was performed to establish which variables predicted the time spent on teaching, including as independent variables the type of teaching, the availability of electronic resources of their students, the need of training for online teaching during lockdown, and the previous training in online teaching. The regression was significant ($R = 0.348$; $R^2 = 0.121$; $F(4341) = 11{,}599$; $p > 0.001$) and evidenced that

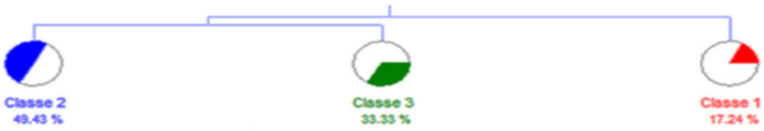
the type of teaching, the students' access to electronic resources, and the need of training during lockdown could predict the time they spent on teaching. The beta coefficients and their significances are presented in Table 4.

Table 4. Regression coefficients and significances of the variables predicting teaching hours during lockdown period.

Variables	Beta	t	*p*
Constant		−0.153	0.879
Type of teaching	0.258	4.999	0.000
Students' electronic resources	0.161	3.137	0.002
Training during lockdown	0.121	2.168	0.031
Previous training in online teaching	0.046	0.818	0.414

3.2. Qualitative Data Analyses

In order to analyze teachers' verbalizations, the responses given to the open questions were subjected to a discourse analysis using ALCESTE [22]. The relevance of the classification was weak since it represented only the 45% of the textual units. The answers given by participants are grouped into three classes (see dendrogram in Figure 1): The first class is called Changes in Working Environment; the second class is named Work Overload; and the third class is called Less Contact with Students.



Work Overload	
Presence	Chi2
overwhelmed	23
work	16
time	13
pressure	7
load	6
dedication	6
personal	6
hours	5
labour	5
stress	4
difficult	4
too much	4
frustrated	4
uncertainty	4

Less Contact Students	
Presence	Chi2
students	80
my	24
contact	17
class	16
teacher	13
performing	12
give	11
can	9
since	8
difficult	8
technology	8
one	7
find	6
to be	6
doubts	5

Changes in Working	
Presence	Chi2
useful	51
meaning	35
change	25
lost	25
level	15
dealing	10
form	10
had	10
students	9
if	8
improve	8
feel	7
to be	5
help	5
teaching	5
circumstance	5

Figure 1. Dendrogram of responses given by teachers to the open questions: What changes do you observe in your professional performance? How do you feel about it?

Considering Changes in Working Environment, this class, comprising 30 ECUs, explains the 17.24% of the variable and its most representative word is Useful. As for Work

Overload, the class, including 86 ECUs, explains the 49.43% of the variable and is mainly represented by the word Overwhelmed. Thirdly, the class Less Contact with Students comprises 58 ECUs and explains 33.33% of the variable, with Student being its most representative word (see more details in Table 5).

Table 5. Responses given by teachers to the open questions: What changes do you observe in your professional performance? How do you feel about it?

Class	χ^2		ECU	%	Word
1		**Changes in Working Environment**	**30**	**17.24**	**Useful**
Sentences	36	The changes that it has unleashed at a profesional level are all negative because I feel that I have lost what gives meaning to my work: dealing with students [los cambios que ha desencadenado a nivel profesional son todos negativos, pues siento que he perdido lo que da sentido a mi trabajo: el trato con el alumnado]			
	23	Obviously, dealing with colleagues and students is different, I feel that I need them to improve as a professional and I also see this circumstance as a challenge to improve at a professional level [evidentemente, el trato con los compañeros y el alumnado es diferente, me siento que necesito de ellos para mejorar como profesional, además veo esta circunstancia como un reto a nivel profesional para poder mejorar]			
	20	I feel that I have lost all authority with my students. It is a very great feeling of frustration and demotivation. I have no control over my teaching role [siento que he perdido toda autoridad con mi alumnado. Es una sensacion de frustracion y desmotivacion muy grande. No tengo control sobre mi papel docente]			
2		Work overload	86	49.43	Overwhelmed
Sentences	15	Too much work, too stressed, overwhelmed [demasiado trabajo, muy estresada, agobiada]			
	14	Too many working hours and increased work stress. I spend much more time. Overwhelmed by not having this time for personal issues [demasiadas horas de dedicación al trabajo y mayor estrés laboral. Empleo mucho más tiempo. Agobiada por no contar con ese tiempo para temas personales]			
	11				
3		Less contact with students	58	33.33	Student
Sentences	24	I am very perfectionist and it is hard for me not to be able to have everything so refined. Although, objectively, I believe that I am performing my duties correctly, my students follow the classes and they are developing their contents' and skills' learning [soy una persona muy perfeccionista y me cuesta no poder tenerlo todo tan arado. Aunque, objetivamente, creo que estoy desempeñando mis funciones correctamente, mis alumnos siguen las clases y están desarrollando su aprendizaje de contenidos y competencias]			
	17	I feel good, although it is true that I miss the daily contact with my students, since now, with the computer, everything is much colder and more distant [me siento bien, aunque es cierto que echo de menos el contacto diario con mis alumnos, ya que ahora por ordenador todo es mucho más frio y distante]			
	14	It is not possible for me to monitor the progress of my students [no me es posible dar seguimiento al proceso de mis alumnos]			

4. Discussion

In the current pandemic situation, and under the lockdown condition, two phenomena have converged: The COVID-19 pandemic itself with the subsequent lockdown, and the lack of training in digital abilities of both teachers and students. As has been said before, the peculiar situation created by the pandemic has given us the opportunity to investigate the real skills of teachers and their digital abilities, and, therefore, their abilities to give an adequate response to the current needs of their students and society. This has also been an opportunity to observe the difficulties and benefits of academic institutions, when offering a comprehensive and beneficial education for all members of the educational system. Teachers have had to adapt to new forms of professional performance, whatever their previous knowledge and experience was, developing skills that probably would not be developed in a regular situation [25]. The teaching staff had to have enough abilities to give an adequate response to the students through digital technologies in the specific situation experienced with COVID-19. However, with this research, those teachers who have refused to use digital technologies, educational innovation, as well as the use of student-centered pedagogies are visible.

A common complaint among educational professionals has been the increase of their workload—mostly the amount of time they have spent on teaching activities. In this study,

predictors and consequences of this work overload have been analyzed. On the one hand, when analyzing the variables related to the increase of working time and responding to the main aim of this study, three of them, type of teaching developed during lockdown, the students' access to electronic resources, and the need of training during this period, have shown their predictive capacity. On the other hand, regarding teachers' perception of the changes observed in their teaching during the lockdown due to the COVID-19 pandemic, three types of opinions are observed. The most relevant class, the one that mostly explains the responses given by teachers on percentages, is the one related to work overload, where Overwhelmed has been the most representative word. The next class is the one lamenting less contact with their students, represented by the word Students. This result corresponds to the perception of the reduced level of interaction found in a previous study [26]. Finally, the third class refers to the changes observed in their teaching, where the word Useful has acquired greater meaning. Therefore, the work overload and finding themselves overwhelmed should be considered the most important consequences experienced by teachers during the lockdown. This would be considered for the future, since it has been evidenced that increasing workload is related to higher distress [27] and anxiety levels [28] in lockdown situations. The importance of this work does not remain exclusively in what has already happened, but in the learning that can be extracted for the future. Therefore, online teaching is here to stay, either exclusively or as support for face-to-face teaching. However, the conditions in which these methods remain should be considered. It is strongly recommended to implement continuous training in diverse online teaching strategies among educational professionals for the purpose of avoiding work overload and overwhelming conditions in any situation, as for developing digital communication skills to improve contact with students. In order to preserve quality in education teachers should be trained in the use of innovative methodologies and in digital abilities, such as online educational platforms and different types of ICT [16]. This should be an important target for educational administrations, as has been already outlined in previous studies [29–32]. In addition, initial teacher training in ICTs should be considered, since there is evidence of it being an adapting instrumental factor for sudden online teaching situations [33,34]. As for higher educational level, teachers' readiness also seems to be a key factor [35]. Furthermore, this pandemic has also revealed the inequalities existing among students in terms of resources. Electronic resources have been incorporated into online teaching strategies and methods, both for the collection of information and for its educational use, acquiring a fundamental role. However, the availability of these resources is limited for some students, and consequently educational centers and governmental educational authorities should take care to provide technological resources to the most economically disadvantaged students, as has already been pointed out in previous studies [36,37]. Although it is true that teacher training is essential, it is as essential as students' preparation with regard to digital abilities and new methodologies. Both must work together using the implicit tools to achieve satisfactory academic, personal, and social goals. Thus, especially at pre-university levels, students must be given the opportunity to obtain and train in ICT facilities, since gaps in access, use, and competencies have been very evident and have created global significant inequalities in the current pandemic situation [38,39]. Therefore, a gradually digital alphabetization for both teachers and students should be considered a priority to foster students' abilities. This training should include online teaching and learning strategies, as well as digital communication skills. Also, resources should be facilitated for all students to narrow the existing digital gap. Finally, this study has not been carried out without limitations. The most important limitation of this work is the procedure for selecting the sample. However, it should be considered that the conditions in which the research was carried out, in a period of extreme lockdown in Spain, made any other way of accessing the sample unfeasible.

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